TABLE 11.—*Mean temperatures at different planes, derived from the curves giving temperature gradient with altitude.* (*°C.*)—Continued.

AT 2,500 METERS.

Centers.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
6	9.4	9.8	13.2	16.2	17.0	16.6	14.0	14	13 3	12.4	10.8	10.0	13.1
7	9.6	11.0	13.8	16.6	17.8	17.6	16.0	16	15.4	13.6	10.0	10.0	14.3
11	9.2	11.1	13.4	15.8	15.8	14.8	13.7	14	13.2	12.2	10.6	9.2	12.8
13	9.0	10.6	14.0	14.7	15.4	14.8	14.2	14	12.8	12.0	10.8	9.2	12.6

AT 3,000 METERS.

Centers.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
11	6.2	7.6	10.0	12.3	12.4	12.0	10.6	11.2	9.8	9.0	7.4	5.8	9.5

TABLE 12.—*Vertical temperature gradient* (*°C.*). *Mean values per 100 meters.*

Centers.	Zones (in meters).						
	0 to 500.	500 to 1,000.	1,000 to 1,500.	1,500 to 2,000.	2,000 to 2,500.	2,500 to 3,000.	0 to 1,500.
1	−0.4	−0.5	−0.6				−0.5
2	−0.5						
3	−0.4	−0.4	−0.5	−0.5			−0.4
4	0.1	−0.2	−0.5				−0.2
5	−0.2	−0.4	−0.5				−0.4
6	−0.3	−0.3	−0.4	−0.5	−0.6		−0.3
7	−0.5	−0.4	−0.3	−0.5	−0.5		−0.4
8	−0.4	−0.5	−0.4				−0.4
9	−0.5	−0.4	−0.4	−0.5			−0.4
10	−0.6						
11	−0.2	−0.4	−0.5	−0.6	−0.6	−0.7	−0.4
12	−0.1	−0.4	−0.6				−0.4
13	−0.4	−0.5	−0.5	−0.6	−0.7		−0.5
14	−0.4						
15	−0.3	−0.6	−0.6	−0.7			−0.5
16	−0.4	−0.4	−0.6	−0.7			−0.5

CLIMATE OF SAN JOSE, CALIFORNIA.

ESEK S. NICHOLS, Meteorologist.

[Weather Bureau, San Jose, Calif., Sept. 26, 1923.]

PHYSICAL BASIS OF THE CLIMATE.

San Jose is situated in latitude 37° 20′ N. at an elevation of about 100 feet above sea level near the western coast of the North American Continent, only about 30 miles distant from the Pacific Ocean.

The city lies in the midst of the Santa Clara Valley, the floor of which is generally nearly flat. In the immediate vicinity, the slope is about 20 feet per mile north-northwestward toward San Francisco Bay, the southern end of which is about 10 miles distant. Isolated hills rise to a height of about 450 feet 3 miles south of town, while it is about 8 miles westward to the foothills of the Santa Cruz Mountains and about 5 miles in the opposite direction to the Mount Hamilton Range foothills. These two members of the Coast Range system and connecting ranges run in a northwest-southeasterly direction approximately parallel with the coast. The valley, the bay, and other valleys both northward and southward lie in the trough between the two ridges. No topographic features prevent the free flow of air between the valley and the bay. The main portion of this practically landlocked body of water is 42 miles from northwest to southeast, 5 to 13 miles wide, and its total area is about 450 square miles. It is an arm of the ocean, salt, and subject to tidal fluctuations. Being more affected by land temperatures, it must be somewhat colder in winter and warmer in summer than near-by parts of the Pacific.

Peaks of the Mount Hamilton Range rise above the 4,200-foot level, and extensive highlands east of San Jose are about 2,500 feet in elevation. These mountains are sufficient to protect the valley to a great extent from the hot, dessicating summer air of the interior of the State, as well as from many cold spells of winter and spring. The Sierra Nevada Mountains, peaks of which ascend to heights above 14,000 feet, lie about 125 miles east-northeastward. As far as we are concerned, the effects of this range are mainly the following: Slowing up and deflecting the general wastward drift of the lower air strata and preventing cold surface air overlying the Great Basin during cold waves from overspreading California.

Although the Santa Cruz Range west of San Jose is only about 2,500 feet in elevation, it deflects and breaks the force of the ocean winds, largely prevents ocean fog from reaching the valley directly, and, by its foehn or chinook effects, reduces cloudiness and rainfall and raises the temperature of west and southwest winds.

The prevailing drift of the lower atmosphere in this part of California is from northwest to southeast, largely from an area of high atmospheric pressure off the coast. Therefore, through the winds, the ocean has a great effect upon San Jose's climate, which it could not have if the wind blew from land to water. The ocean is the main source of moisture. For many reasons a body of water maintains a more constant temperature than does a body of land under the same conditions; so the ocean, aided by the bay, modifies the temperature, making winters warmer and summers cooler than otherwise. The surface water near the coast is colder than that some hundreds of miles out to sea, due to the up-welling of cold water along shore, although the main surface drift in this part of the ocean comes from the northwest in the California Current and is of comparatively low temperature for the latitude. The average annual water temperature near the coast west of this district is reported as about 55°, varying from about 50° in winter to 60° in late summer.

SOURCE OF CLIMATIC DATA.

The following brief description of the climate of San Jose is based mostly on records kept at the Weather Bureau office in that city. The instruments and their exposures have been practically unchanged from a short time after the San Francisco earthquake of 1906 to date, and the data for the 17-year period form a homogeneous series. The meteorological instruments used are of types too well known to need any description here, being standard equipment of regular United States Weather Bureau stations. The most important are the following: Mercurial barometer, aneroid barograph, Robinson cup anemometer, 6-foot wind vane, electrical sunshine recorder, tipping bucket rain gauge, maximum and minimum thermometers, Richard thermograph, whirled psychrometer, and quadruple register. The accompanying Table No. 1 gives many of the data used in the preparation of this article, as well as many details that can not be referred to in a discussion of reasonable length. Further details are given in the following Weather Bureau publications particularly: "Climatological Data, California Section," in monthly and annual numbers; "Climatological Data for the United States, by Sections, Section 14"; Monthly and Annual Meteorological Summaries for San Jose; "Monthly Weather Review"; annual reports of the Chief of Weather Bureau.

ATMOSPHERIC PRESSURE.

The average atmospheric pressure, in terms of the height of a mercury column it can support, is 29.89 inches, which is only 0.15 inch less than at sea level in the same locality. Great and sudden changes are unusual. The annual range is usually less than 1 inch.

SUNSHINE AND CLOUDINESS.

The electrical sunshine recorder is exposed on the tower of the Federal Building, in which the office is located. Eye observations of cloudiness, supplementing the instrumental record, have been taken regularly at 7 a. m. and 5 p. m. throughout the 17 years and at local mean noon for 6 years, as well as at other times, particularly during the daylight hours.

In this latitude the length of day varies from 9.6 hours at the time of the winter solstice to 14.7 at the summer solstice; while the midday altitude of the sun is about 29° at the former time and about 76° at the latter. However, the seasonal variation in the amount of insolation, or radiant energy from the sun, received at the earth's surface is greater than these astronomical data taken alone would indicate; for there is an average of about 84 per cent of the possible sunshine from June to August, inclusive, when sunshine is most intense, and but 56 or 57 per cent in December, January, and February. The average number of hours of sunshine in July is 384.5, while the number in December is only 167.6. But the greater intensity and duration of summer sunshine is somewhat offset by the greater absorption of insolation by water vapor in the atmosphere during that season; e. g., during July, 1922, the mean noon vapor pressure was 0.471 inch, while the corresponding mean for January was 0.201 inch. On the other hand, the outgoing earth radiations are absorbed to a greater extent by the increased vapor of summer, and cooling is thus retarded.

No local observational data on intensity of insolation are available; but, applying Zenker's factors for intensity of radiation on a horizontal surface for midday solar altitudes to the average numbers of hours of sunshine from 12 to 1 p. m. during July and December, we have—

For July:	
Factor for solar altitude 76°	0.74
Average hours of sunshine	.995
For December:	
Factor for solar altitude 29°	.30
Average hours of sunshine	.706

Then $0.74 \times 0.995 = 0.734$ and $0.30 \times 706 = 0.212$ are the relative amounts of insolation received during midday during the two months; or, the amount received in July is

$\frac{0.734}{0.212} = 3.5$ times that received at that time of day in December (if the effect of difference in amount of atmospheric moisture be neglected).

Since the altitude is only about 100 feet, atmospheric effects on both incoming and outgoing radiations are practically what they would be at sea level.

The average monthly percentages of possible sunshine are shown on Figure 1. The average cloudiness varies from 1.8 in July to 5.4 in January, using the scale 0 to 10, in which 0 indicates no clouds and 10 sky totally covered. There are practically no days classed as "cloudy" during June, July, and August; an average of only 2 in September; and 4 or 5 each in April, May, and October; while December to March have 10 to 14 apiece, and only 10 to 14 clear days each.

Not only do the Santa Cruz Mountains prevent the ocean winds from reaching the valley directly, but they also considerably modify the air that does pass over them. Consider a body of nearly saturated air moving up the slope from the ocean. With ascent, pressure decreases and the air cools by expansion. Soon the dewpoint is reached; water begins to condense to the liquid form and some of it falls in the form of rain. After passing the summit ascent soon ceases, cooling and condensation stops. A little later the descent to the valley begins, the air is warmed by compression, and the cloud it carries may soon be entirely evaporated. Often these dissolving clouds can be seen from San Jose, hanging ragged-edged over the summits of the western hills. The wind reaches the valley floor with a higher temperature than it had at the same elevation on the other side of the mountains, for the descending clear air warms more rapidly than the cloudy ascending current cooled; because the cooling was retarded by the "latent heat" liberated by the condensing water. If the air continues its progress eastward cooling takes place as the Mount Hamilton Range is ascended; clouds and rain may form there, though the tendency is less than in the moister current ascending the Santa Cruz. The occurrence of fog is discussed below.

TEMPERATURE AND HUMIDITY.

The temperature and humidity instruments referred to above are well exposed at a height of 12 feet above ground over sod in a double-roofed louvered shelter that is situated in City Hall Park, across the street from the office building.

As might be expected, winters are mild and summers are moderately warm. The average annual maximum and minimum temperatures [2] are, respectively, 69.3° and 45.1°, giving an average daily range of 24.2° and an annual average temperature of 57.2°. The average for July, usually the warmest month, is 66.4°, which is derived from an average maximum of 80.1° and an average minimum of 52.7°. Commonly the summer heat is tempered by the breezes from San Francisco Bay; but in 6 out of the 17 years of record readings of 100° or higher have been recorded. All months from May to September, inclusive, are credited with at least one such occurrence each. The highest recorded is 103°. The lowest annual maximum is 91°; and the average number of days with maximum of 90° or above is only 11, 3 of which may be expected in June, 3 in July, 2 in August, 3 in September, and occasionally 1 in May or October. The highest daily minimum is 63°, so nights are always cool, even following a hot day. Also, during the very hottest weather discomfort is lessened by the fact that both the dewpoint and the relative humidity are then lower than usual, evidently due to drift of air from the

[2] Temperatures are recorded in Fahrenheit degrees. All mean daily, monthly, and annual temperatures are determined from the daily maxima and minima.

interior of the State probably over the Mount Hamilton Range; also the hot spells seldom exceed 3 days in length.

The march of the average maximum and minimum temperatures from month to month throughout the year is shown graphically on the line diagram, Figure 1.

December and January are the coldest months, having averages about 48°, average maxima of 57 or 57½°, and average minima of 38.4°. It will be noted that the mean minimum for these months is only about 14° lower than the same datum for July; while the average daily range is about 19°—8° less than for the latter month. The lowest reading recorded is 22°; thus the extreme range is 81°. Temperatures below the freezing point of water, 32°, have occurred in every month from October to March, inclusive; but the total number of such days per year averages only 16, of which 5 occur in December, 6 in January, 2 in February, 2 in November, 1 about every 2 years in March, and on rare occasions 1 in October. In April and May, however, temperatures sometimes drop very near the freezing point, and damaging frosts may then occur, 33° having been reached in the former month and 35° in the latter.

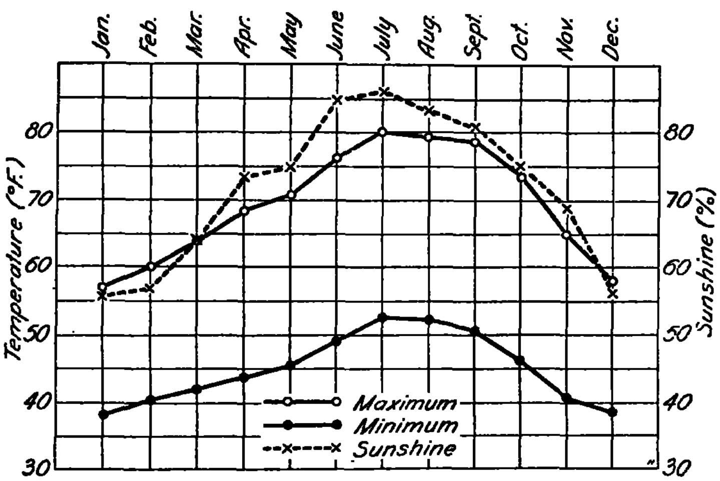

FIG. 1.—Monthly averages of temperature and sunshine, San Jose, Calif.

The average change of mean temperature from one day to the next is 2.6°, and is only slightly greater in winter than in summer. Changes of such severity as to be denominated "cold waves," even in California, are very rare. The fact that spring is colder than fall is undoubtedly largely due to the temperatures of the ocean and the bay being lower during the former season.

FROST.

The average date of the last killing (very severe) frost in spring is February 11 and of the earliest in fall, December 5; giving the average length of the growing season, 297 days. The latest such frost in spring occurred March 31 and the earliest in autumn on November 12. However, there are usually frosts of less severity, sometimes sufficient to damage tender vegetation considerably, in April or May and in November; and in the latter part of nearly one-half of the Octobers. Some frost occurs early in nearly one-half of the Mays.

Records taken by cooperating observers, using standard thermometers properly exposed, show that certain localities on the floor of the valley have greater frost probability and lower spring and fall minimum temperatures than San Jose has. This difference is due to at least three causes: First and most important, drainage of cooled night air into low places; second, exposure of the country instruments at 5 feet above ground, where temperatures are lower on frosty mornings than at the 12-foot level, where the San Jose instruments are exposed; third, because of effect of the city in raising its local temperature, which effect is slight in a small city like San Jose and is undoubtedly of little consequence at the Weather Bureau shelter in the park. On the other hand, certain other outside localities, especially in the foot hills, on either side of the valley, have higher minimum temperatures and are freer from frost than is San Jose, the records of which may, therefore, be taken as fairly representative of average conditions in the valley.

HYGROMETRIC DATA.

Averages of relative humidity for noon and 5 p. m. are available and are given in Table 1; while those for the former time are shown graphically on Figure 2. The temperature, in its nocturnal fall, usually reaches the dew point of the preceding evening, so the morning air is usually of high relative humidity; but, as the air warms up during the forenoon, relative humidity falls as a matter of course and is least during the warmest part of the day, as a rule. The noon average is highest in December, 71 per cent and least in June, 46 per cent. Thus the summer relative humidity is neither so high that the warmest part of the day is unduly oppressive nor so low that the air is then parching. During the year 1922 the noon dewpoint means varied from 57° in July to 34° in January.

WINDS.

The wind vane and the anemometer are exposed on the tower of the Federal Building at heights of 112 and 110 feet, respectively, above ground.

Particularly during fair weather the surface wind at San Jose is an excellent example of land and sea breezes combined with mountain and valley breezes. During the day the sunshine (for a number of reasons) raises the temperature of the land surface more than it does that of the water surface. The lower air over the land then becomes warmer than, expands more than, and becomes lighter than that over the water of San Francisco Bay and the ocean. The resulting pressure difference causes a wind to blow from the water to the land. Also, the heating of the air lying on the valley slopes produces an up-slope pressure gradient acting on the surface air, the resultant of which at San Jose is from the northwest, acting in conjunction with the sea breeze from the bay. Further, much of the air flowing from the high-pressure area off the coast to the heated interior of the State passes through the Golden Gate and over low hills near that strait, and some of it is deflected up the Santa Clara Valley.

The combined effect of these three causes is so great that northwest winds prevail nearly all the 24 hours of the day during June, July, and August, during the afternoons and early evenings of winter, and to an intermediate extent during the transition months of spring and autumn. Northwest is the prevailing direction for the year as a whole and for all months except December, January, February, and November, while it equals southeast during the last-named month. Northwest winds average much stronger than other directions; for, as the temperature difference between land and water increases, the velocity rises, because pressure differences become greater, to an average of 10 miles or more per hour during afternoons from June to September, inclusive, and to a somewhat lower velocity afternoons during other parts of the year.

While the land heats up faster by day than does the water, it also cools more rapidly by radiation at night, so that by morning, even much of the time in midsummer, the air lying upon it becomes colder and denser than that over the water. Consequently, with the setting of the sun, the wind slackens and finally, before morning, usually is reversed in direction and blows toward the water, from south or southeast. This reversal is aided by the usual phenomenon of air drainage in valleys at night, the drift of cooled dense air down the slopes. These fair-weather south-southeasterly winds are neither so strong nor so persistent as their opposite, the average velocity in early morning being about 3 miles per hour. They may continue through the forenoon, until the heating of the land in the sunshine brings in the northwest wind; but often there are hours of variable winds or even of calms. At least two explanations for their weakness offer themselves: First, they oppose the general drift from the northwest, the continuance of which through the morning hours is often shown by its burden of low-lying stratus or strato-cumulus cloud, locally designated "high fog"; the south-southeast current may be only a thin layer, a few hundred feet in thickness, underrunning the warmer air from the bay. Second, the morning temperature depression is less than the afternoon excess, with respect to the water temperature.

During midsummer the land at times remains all night warmer than the water; so south-southeast winds are least frequent during that season. In spring, fall, and winter the land usually gets the cooler; in fact, at times it does not, during the day, become as warm as the water; so breezes toward the water are then most frequent. Also, during these seasons, particularly winter, there is more cyclonic control, by low-pressure areas passing eastward north of this district, which still further increases the percentage of south-southeast winds.

There is, on account of stronger daytime convection, greater diurnal range of velocity in summer than in winter; during the cold months the variation is from about 4 to 6 miles per hour during early morning to about 7 to 9 during daytime. During transition months diurnal range of velocity is intermediate.

Although the northwest winds average the strongest, the very highest velocities are from the south, southeast, or east, all records of 40 miles per hour or above are from these three directions; less than one-half of the years of record have such high velocities, however, and all occurred in December, January, February, April, or May. The highest of record is 48 miles per hour. The average annual velocity is 5.7 miles per hour. Monthly averages do not vary much, but October and November have less than 5 miles per hour.

PRECIPITATION.

The main sources of moisture in the vicinity of San Jose are, of course, the Pacific Ocean and San Francisco Bay. The most of the rainfall is cyclonic, mainly with south and southeast winds, but to a lesser extent with east and westerly. During summer the prevailing drift of lower air is from a high-pressure area off the coast to the warmer land; and the cyclonic storms have decreased in energy and have taken paths so far northward that rain is infrequent in California. During winter, and to a less extent in spring and autumn, the storms increase in intensity, follow paths farther southward, and produce moderate rainfall in the Santa Clara Valley. Many rains occur without accompanying barometric change, especially during the warmer months of the year. Showers may accompany special developments of the

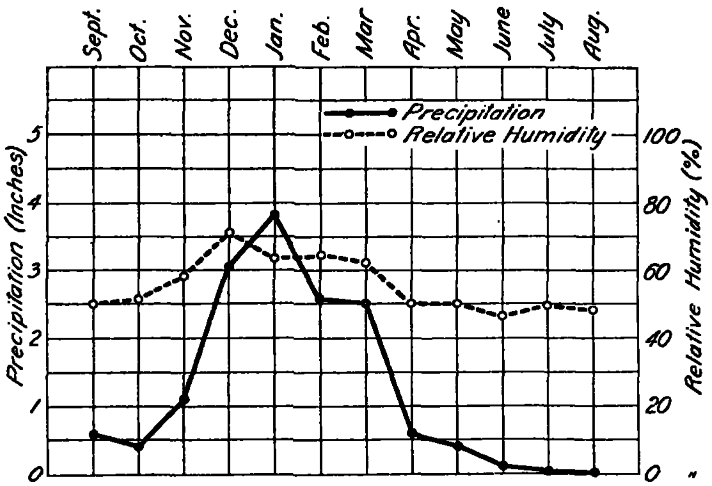

FIG. 2.—Monthly averages of precipitation and relative humidity, San Jose, Calif.

semipermanent low pressure over the interior of California, Arizona, and near-by districts. A very exceptional rain occurred in September, 1918, as an accompaniment to a tropical hurricane far to the southward.

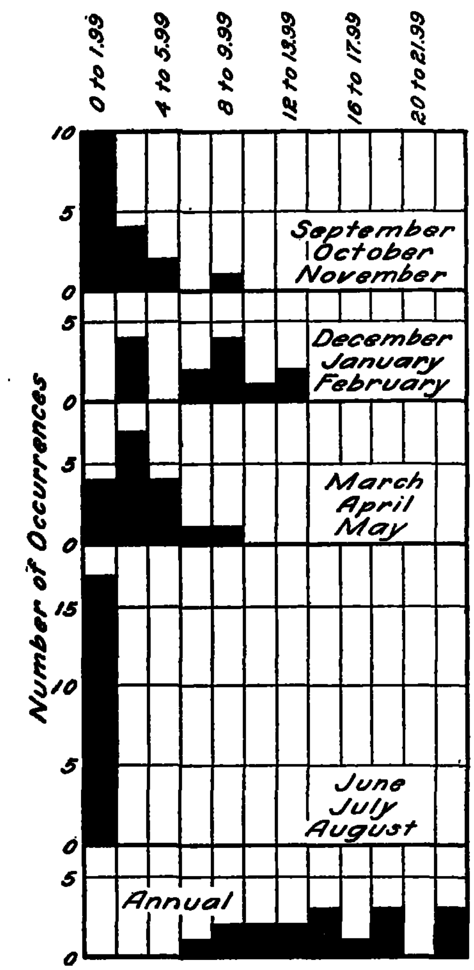

FIG. 3.—Frequencies of seasonal and annual precipitation of various depths, San Jose, Calif.

Because of the effects of the Santa Cruz Range, described briefly above, precipitation is less on the floor of the valley than in the ranges on either side, especially the west. San Jose's record is typical, as to total amount, rate, and distribution, of the valley floor; and as to proportionate distribution throughout the year for the entire valley. But Los Gatos on the southwest at about 500-foot elevation and Lick Observatory on Mount Hamilton at about the 4,200-foot level on the east, have about double San Jose's annual total. A short record at Wrights, among the Santa Cruz, shows annual totals from about three to more than seven times the corresponding amounts at San Jose.

and December's slightly above 3 inches. February and March average about 2½ inches; November, over 1 inch; September, October, April, and May, not far from one-half inch each. These facts are shown graphically on the line diagram, Figure 2, in which the monthly averages are given by the heights of the broken line above the base at the points where the monthly lines are intersected.

However, an inspection of the table of individual monthly and annual amounts (not published here for lack of space) shows that averages give a very inade-

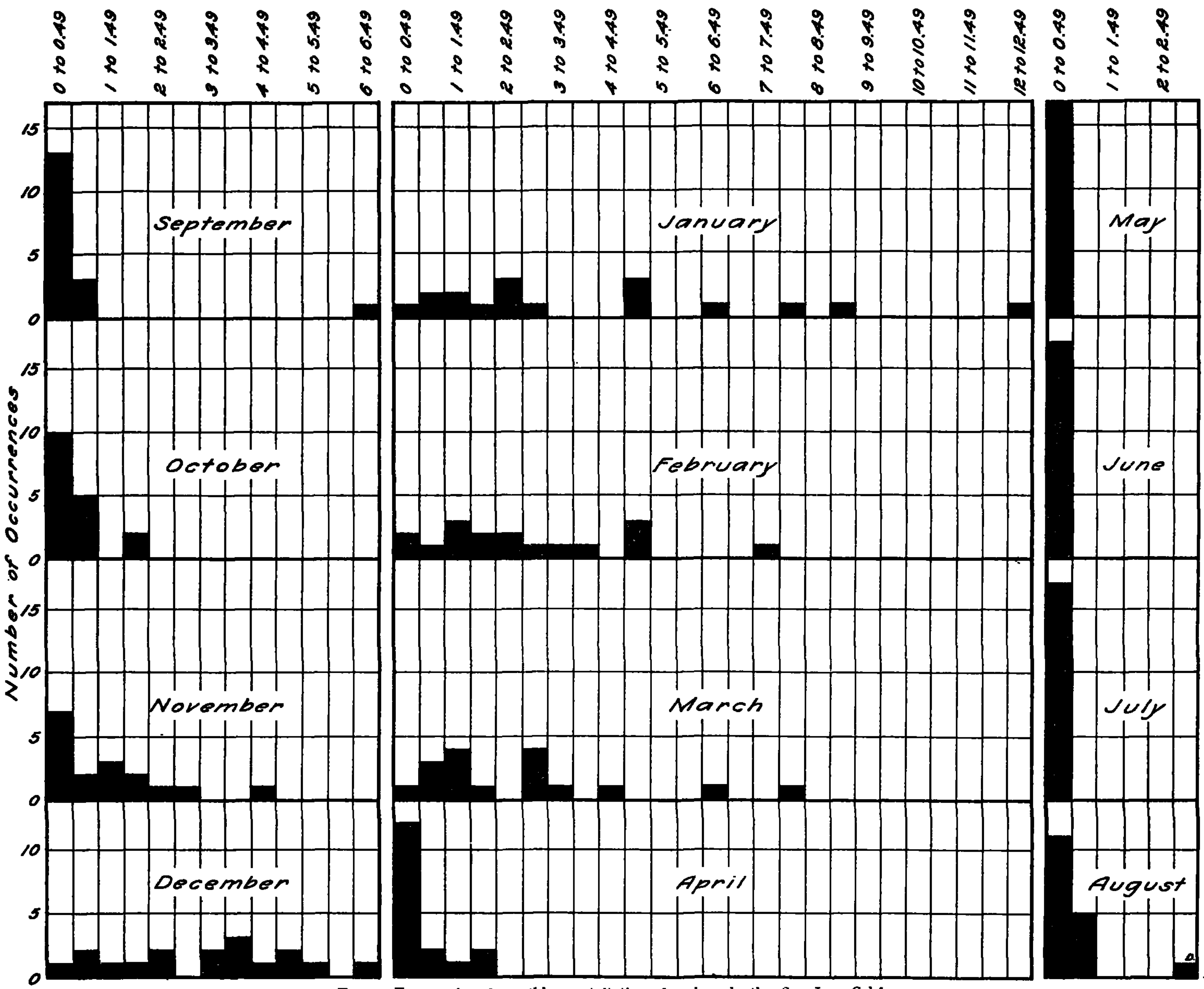

FIG. 4.—Frequencies of monthly precipitation of various depths, San Jose, Calif.

The standard tipping-bucket rain gage at the San Jose station is exposed in the park near the shelter, the top being 3 feet above ground; but the electrical connections were not made until December, 1907, since which time the record of hourly amounts is available, with only short interruptions.

Table 1 shows that summers in San Jose are nearly rainless. Moderate rains occur in winter and light rains in spring and fall. The average annual total is slightly more than 15 inches. January's average is nearly 4

74022—23——2

quate idea of the variations from month to month and from year to year. Therefore, the frequency diagrams, Figures 3 and 4, have been prepared. Here the length of any vertical bar, measured by the scale at its left, gives the number of times the precipitation, of the month or period represented, has fallen within the limits given above the bar. The limits are arranged consecutively, increasing from right to left; by 2-inch intervals in the annual and trimonthly diagrams, and by half-inch intervals for the months.

Amounts for each June, July, and August during the entire 17 years fall within the lowest monthly class—less than one-half inch. In fact, the table of monthly amounts shows that usually July and August pass without even a sprinkle, and that June often does so. The lowest class is also the most frequent (the "mode") during September, October, November, April, and May; and has occurred once or more in each of the remaining months, even in January. September and May often have no rain or only a sprinkle; and this is occasionally true of October and April. September has one very exceptional case, referred to above, falling in the class above 6 inches. The number of cases in the higher classes increases as we pass from summer through the fall or spring to winter. March shows a double mode, one at about 1 inch and another from 2½ to 3 inches. December, January, and February have no prominent mode, but show wide variations from the 1st to the 13th or higher classes.

For three fall months, as a whole, the lowest class used, less than 2 inches is the most frequent; the summer amount invariably falls within this lowest class. Spring favors the 2d class, between 2 and 4 inches, but the 1st and 3d are each fairly numerous. Winter rains vary widely, the 2d class, 2 to 4 inches, being as frequent as the 8th, 14 to 16 inches. Annual amounts vary widely also; the year has no prominent mode.

Dry seasons and months are more frequent than wet ones, for excesses are usually greater than deficiencies. As an extreme example, the November average is over 1 inch, but the mode is the first class, less than one-half inch.

It is fortunate that much of the Santa Clara Valley is underlaid at slight depths by gravel beds, which form excellent storage reservoirs for the precipitation that falls during the wet seasons over the district. Numerous wells tap the underground supply of water, without which irrigation would be impracticable, since the valley has no perennial streams with very material flow.

The rain nearly always falls at a moderate rate, and when heavy is likely to be steady. There has been, according to the standards of the Weather Bureau, no occurrence of "excessive precipitation" for short periods, such as 5 minutes up to 1 hour; the only excessive falls have been for periods nearly or quite 24 hours in length. More than one-half of the years considered have had no 24-hour amount as great as 2 inches; but on two occasions the amount was more than 4 inches, the greatest on record being 4.56. The greatest amounts recorded during certain shorter periods within the past 12 years are as follows: 2 hours, 1.11 inches; 1 hour, 0.65 inch; 30 minutes, 0.36; 15 minutes, 0.34; 10 minutes, 0.27; 5 minutes, 0.17. The average number of days per year with 0.01 inch or more is 64, of which December, January, February, and March have from 9 to 12 each; July and August, none. The average annual number with 0.04 inch or more is 47; with 0.25 or more, 19; and with 1 inch or more, only 2.

Snow is practically unknown in the city; there are two or three records of traces, but it never lies on the ground. It is not uncommon in the near-by hills, however. Typical thunderstorms do not occur; on the average of once or twice a year light thunder is heard—nearly always in winter, September, or August. A little small hail falls about once in two years, in winter or spring.

During June, July, August, and September the infrequent rainy days usually occur singly or in pairs. As we pass to winter months, through either spring or fall, longer rainy periods are found in the record, until in December, January, February, and even March occasional groups of 10 or more successive days with measurable rainfall occur.

FOG.

Light fog is not infrequent. Dense fog (sufficiently thick to obscure objects at a distance of 1,000 feet) occurs for a time on nearly 30 days per year, least frequently from March to July, inclusive; it is particularly uncommon in May. Some of this fog may form over the land during night, as a result of condensation of water vapor when the air is cooled below its dewpoint. More often the fog forms over the bay or the ocean, and is carried by the wind to the valley.

As already noted, the fog-bearing current from the water, being comparatively warm and moist and, therefore, light, may be underrun by the thin layer of colder, denser air blowing toward the bay, particularly in the early morning hours. In this case the amount of condensation may be increased, for the following reasons at least: First, mixture of the two currents at their boundary (the lower having become, by cooling, nearly saturated by morning); second, cooling of the upper layer because of expansion during ascent as already explained; third, cooling by radiation to the ground, the lower air, and space; fourth, expansional cooling at crests of waves formed between the two currents. In fact there are undoubtedly occasions when "high fog," as this phenomenon is designated locally, forms over the land as a result of these causes alone.

This elevated fog thus forms a layer of low-lying stratus or strato-cumulus cloud over the valley; but a true fog where it meets the foothills on either side, since a fog is simply a cloud that reaches the ground. The foothills may be plainly visible from San Jose; while above the cloudy layer the sun shines from a cloudless sky upon the higher hills and the foggy sea that fills the valley from wall to wall. Much of the summer cloudiness is of this nature and occurs in the morning. The clouds usually evaporate and the sun breaks through by 10 a. m., often with surprising suddenness.

CONCLUSION.

In conclusion it may be said that the principal seasonal contrast is in precipitation and cloudiness rather than in temperature, between a "wet" season and a "dry" season. Midsummer is rainless or nearly so; moderately warm during the day (occasionally hot) but cool at night; sunny; with considerable diurnal range in wind velocity, which is greatest and from the northwest afternoons and least and from the opposite direction early in the morning; no gales occur. The winters are relatively mild and cloudy, with light rainfall and without snow; winds are usually comparatively light, but gales occur occasionally. Spring and autumn are transition months in all important respects; September and October particularly are usually mild and pleasant; frosts sometimes occur as late in spring as the middle of May. The seasonal and daily variations of relative humidity are moderate. Fogs are not infrequent. Severe thunderstorms do not occur. Invigorating temperature change is provided by a considerable diurnal range, particularly in summer, rather than by strong seasonal contrasts.

TABLE I.—*Meteorological extremes and averages, San Jose, Calif.*

Data and length of record (years).	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Temperature (17):													
Highest recorded	76	76	88	90	102	101	103	102	103	97	85	72	103
Lowest recorded	22	25	30	33	35	38	43	42	40	31	27	23	22
Average maximum	57.0	60.3	63.8	68.2	71.0	76.4	80.1	79.7	78.5	73.4	65.2	57.5	69.3
Average *minimum*	38.4	40.9	42.1	43.7	45.9	49.4	52.7	52.2	50.2	46.2	40.9	38.4	45.1
Average monthly and annual	47.7	50.6	53.0	56.0	58.4	62.9	66.4	65.0	64.4	59.8	53.0	48.0	57.2
Average number of days with—													
Maximum 32° or below	0	0	0	0	0	0	0	0	0	0	0	0	0
Maximum 90° or above	0	0	0	0	*	3	3	2	3	*	0	0	11
Minimum 32° or below	6	2	*	0	0	0	0	0	0	*	2	5	16
Precipitation (inches):													
Average (17)	3.83	2.58	2.51	0.56	0.41	0.09	0.01	0.01	0.55	0.49	1.14	3.06	15.24
Greatest monthly and yearly	12.38	7.02	7.75	1.95	2.69	0.46	0.09	0.08	6.33	1.71	4.10	6.39	22.75
Least monthly and yearly	0.10	0.09	0.31	0	0	0	0	0	0	0	0.13	0.43	6.52
Greatest in 24 hours	4.56	2.65	2.60	0.78	1.24	0.36	0.08	0.08	4.47	0.90	1.73	2.77	4.56
Greatest amount in—													
1 hour (12)	0.65	0.45	0.50	0.31	0.21	0.08	0.06	0.08	0.57	0.24	0.39	0.36	0.65
5 minutes (12)	0.17	0.12	0.18	0.08	0.06	0.02	0.02	0.02	0.13	0.08	0.17	0.14	0.18
Number of days with 0.01 inch or more	12	10	9	4	3	1	*	*	2	4	6	11	64
Sunshine and cloudiness:													
Sunshine, per cent of possible	56	57	64	74	75	85	86	83	81	75	69	56	72
Average cloudiness (17)	5.4	5.3	4.7	3.4	3.2	2.1	1.8	2.1	2.4	3.1	3.7	5.3	3.5
Number of days—													
Clear	11	10	14	18	20	24	28	27	22	19	16	11	220
Partly cloudy	6	7	7	7	7	5	3	4	6	8	7	7	74
Cloudy	14	11	10	5	4	1	0	0	2	4	7	13	71
Relative humidity:													
Average at noon (5)	64	65	62	50	50	46	50	49	50	53	58	71	56
Average at 5 p. m. (16)	68	63	61	55	54	51	52	53	53	54	61	70	58
Wind (velocity in miles per hour):													
Average velocity (16)	6.1	6.1	5.9	6.3	6.3	6.2	6.1	5.7	5.1	4.8	4.9	5.6	5.8
Maximum velocity (for 5 minutes)	46	48	36	44	42	34	29	36	27	34	35	43	48
Prevailing direction	SE.	SE.	NW.	NW.	NW.	NW.	NW.	NW.	NW.	NW.	NW. and SE.	SE.	NW.

*Less than 1.

Cloudiness, recorded to tenths. Temperature in degrees Fahrenheit.

GROUP DISTRIBUTION AND PERIODICITY OF ANNUAL RAINFALL AMOUNTS.

By ROBERT E. HORTON, Consulting Hydraulic Engineer.

[Voorheesville, N. Y., August, 1922.]

INTRODUCTION.

The longest existing continuous rainfall record is that at Padua, Italy. Inasmuch as this record is of great value, on account of its length, for studies relating to variations in mean rainfall, it is given herewith in convenient form and in English units, in Table No. 1.

Examining a long rainfall record, such as that of Padua, it will be noticed that a large proportion of the total number of years occur in groups of high or low years, such that all the years in a group are either above the mean or else below the mean. This tendency to grouping of like years occurs even where there is no visible indication of an orderly or cyclic arrangement or periodic recurrence of groups. Now if the occurrence of successive like years was a matter of pure chance, then there would be in any record a certain probable number of groups of 2, 3, 4, 5, etc., successive like years. Inasmuch as the occurrence of groups of like years, especially low years, is of great importance in the application of rainfall data, it becomes of interest to inquire how the actual grouping of like years compares with that which would result from a chance distribution of wet and dry years.

The reasoning here applied to rainfall records may also be applied to other hydrologic data, such as the distribution of groups of cold and warm years, the occurrance of groups of low or high run-off in streams, the occurrence of groups of years of large or deficient yield of crops, etc. In order to make the discussion general, using rainfall records for purposes of illustration, values of the data under discussion will be described as "events"; a series of events which occur in the same way, as, for example, rainfall years all above the mean, or the results of the tossings of a coin where all cases are heads, will be described as "like events"; events which occur in opposite ways, as the alternate tossings of heads and tails with a coin, or the occurrence of wet and dry years in succession, will be described as "unlike events"; events which correspond to the occurrence of heads in the tossing of coins, or to years of rainfall, stream yield, crop yield, temperature, etc., greater than the mean, will be called "plus events," and the opposite will be called "minus events." Any series of n consecutive events, whether like or not, may be called a group. A series of n events which are all like, and which events are both preceded and succeeded by at least one unlike event, will be described as an "n group" of events. A series of events arranged in the order of their occurrence will be described as a "record." The difference in value of an event from the mean value will be called its "departure." In the discussion of the accuracy of record means, it is sometimes convenient to use the fiction "true mean," meaning thereby the result which would be obtained from a record of indefinitely great length containing no observational errors, as distinguished from the mean of any series of m events. The illustrations here given are mainly derived from rainfall, for which the letter p is commonly used to designate the mean. In order to make this discussion more general, and to reserve the letter p to designate probability, the letter M will be used to designate the mean, whether of rainfall or some other series of events.